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Tannin Evaluation of One Hundred Sixty-Three Species of Plants

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For a number of years the United States Department of Agriculture has been interested in the development of new domestic sources of vegetable tanning materials and has previously reported on the possible utilization of hemlock bark¹, Sitka spruce bark², Florida scrub oak barks³, Tennessee Valley Oak barks⁴, sumac leaves⁵, and canaigre tubers⁶.

We have recently had an opportunity for the tannin evaluation of a large number of plant species received at this laboratory for examination for steroid sapogenins. In addition to this determination, qualitative tests have been made for flavanols, alkaloids, sterols, phenols, and tannin. Some

*A Laboratory of the Eastern Utilization Research Branch, Agricultural Research Service, United States Department of Agriculture.

of these results have been reported in two publications^{7, 8}. The Hides, Tanning Materials and Leather Section has made analyses of those plants which gave favorable qualitative tests for tannin and of which there was sufficient available material. The analyses were made by the official methods of the American Leather Chemists Association⁹, modified by varying the hide powder used in proportion to the tannin content.

In the cortisone survey it was not necessary or possible to obtain representative specimens of every plant family, nor to obtain samples of every portion of a specimen. Therefore, the results of the tannin survey are necessarily incomplete. Analyses, showing tannin content and purity, afford a preliminary screening process for new materials. However, other requirements must be met before the suitability of a material for the production of a commercial tanning extract can be established.

1. The material must be cheaply available, either actually or potentially, in sufficient quantities for the operation of an extract plant.
2. Facilities for power, water, labor and transportation for an extract plant must be easily available.
3. It must be possible to extract the tannin cheaply to give an extract producing satisfactory leather.

It is doubtful if a tanning extract could be produced economically from material containing less than 10 per cent tannin, if the material was used solely as a source of tannin. If it has other uses, so that the tannin could be regarded as a by-product or a co-product, the minimum tannin requirement might be reduced to 8 per cent. In any case, the purity should be above 50.

From the first 2,000 plant collections examined, about 1,823 were eliminated by the preliminary qualitative tests as containing little or no tannin. Of the remaining 177, 69 were analyzed. Of these 16, or 23 per cent, contained more than 8 per cent tannin and had purities above 50. Of these 16, two species of Terminalia, the Caesalpinia and the Eucalyptus either are now used for tanning or are closely related to species now being used.

Table I gives the data on the 16 samples analyzed which appeared most promising. Table II gives the data on the remainder of the analyzed samples. Table III gives data on samples which appeared promising by the preliminary screening tests but which could not be analyzed because of an insufficient amount of sample. The botanical identification of those plants taken from the first 1,000 collections is from the publications previously mentioned^{7, 8}. Data on the remaining 1,000 collections have not yet been published, but identifications are by the same authors. Some data on common names, habitat, etc. are taken from Bailey¹⁰. Data on the original sources of the plants

and of the sources of the specimen samples are given to indicate the optimum location for cultivation, if desired.

There are 108 samples listed in Table III. Using the figure of 23 per cent obtained from Table I and II it might be assumed that about 25 of these samples would pass the analytical screening test. This would give a total of 41 from the original 2,000 specimens.

Further work on one of the samples indicates that, in addition to tannin analysis, a more detailed study is necessary in order to determine the potential value of a plant product as a source of tannin. The rhizomes of smilax, *Smilax laurifolia*, contained 15.4 per cent tannin and had a purity of 57.94. The plant is abundant and easily grown along the Atlantic coast of the United States. Since these conditions are favorable, further tests were made of this material. It was found, however, that the rhizomes would be difficult and expensive to harvest because of their configuration. Comminution would be expensive, inasmuch as wet shredding is difficult, and the dry material is extremely hard. Furthermore, tannin extraction was slow and inefficient and the extract produced was poor, having a tendency to gelatinize. Penetration during tannage was slow and the leather produced was of poor color with a harsh, rough grain. It is doubtful even though the material has a favorable tannin analysis, that a satisfactory extract could be produced.

The results of these tests cannot be taken as a complete tannin survey. However, some conclusions may be drawn as to the presence of tannin-bearing species in the various families. Of more than 500 species of Amaryllidaceae, none contained more than insignificant amounts of tannin. Of more than 300 species of Liliaceae only a few species of Smilax, Urginea and Nolina contained tannin. Very few species of Bignoniaceae, Compositae, Dioscoreaceae, Oleaceae, Palmaceae, or Solanaceae contained appreciable amounts of tannin. High proportions of tannin-bearing species were found in the Aceraceae, Anacardiaceae, Betulaceae, Caprifoliaceae, Hamamelidaceae, Iridaceae, Leguminosae, Myrtaceae, Rosaceae, Sapindaceae, Sapotaceae, and Saxifragaceae. It was not possible to draw conclusions about other families.

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TABLE II (Continued)

Botanical Name and Common Name if Known	Habitat	Part of Plant Analyzed*	Source of Material Analyzed	(Results Calculated to Moisture-Free Basis)				Purity Basis Tannin %
				Total Extractive %	Soluble Extractive %	Tannin Analysis Solubles in Non-Extractive %	Tannin Sol. Ext.	
Ericaceae (continued)								
<i>Kalmia latifolia</i> , Mountain Laurel, Calico bush	North America	lc, fr.	Highlands, N. C.	36.67	32.26	4.41	16.86	15.40
Oxydendrum arboreum, Sour-wood or Sorrel tree	East. No. America	One sample and one fr. identif. lost.	Raleigh, N. C.	33.22	31.71	1.51	21.87	9.84
Oxydendrum arboreum, Sour-wood or Sorrel tree	North America	lc, fr.	Highlands, N. C.	11.87	11.20	0.67	8.35	2.85
Rhododendron maximum, Great laurel	Asia	le	Chico, California	30.17	27.39	2.78	15.00	12.39
Euphorbiaceae				33.83	32.83	1.00	21.34	11.50
Aleurites fordii, China wood-oil tree	North & West China	lc	Chico, California	36.07	34.31	1.76	22.26	12.05
Fagaceae				36.07	34.31	1.76	22.26	12.05
<i>Castanea mollissima</i> , Chinese chestnut				36.07	34.31	1.76	22.26	12.05
Juglandaceae				36.07	34.31	1.76	22.26	12.05
<i>Carya illinoensis</i> , Pecan	Central U. S. & Mexico	wp (1)	Chico, California	50.74	49.20	1.54	37.70	11.50
Leguminosae				50.74	49.20	1.54	37.70	11.50
<i>Caesalpinia pulcherrima</i> , Barbados Pride, Barbados flower, Fence Dwarf Poinciana	Generally in tropics	le, fr, in.	Coconut Grove, Fla.	32.48	30.98	1.50	19.65	11.33
<i>Cassia fistula</i> , Pudding Pipe India tree, Golden Shower		le, fr.	Glen Dale, Maryland	29.81	27.96	1.85	23.77	4.19
<i>Cassia marginata</i>	Many Cassia in warmer parts of the world	le, fr.	Coconut Grove, Fla.	36.92	35.62	1.40	23.77	11.85
<i>Cassia nigra</i>	Many Cassia in warmer parts of the world	le, in.	Coconut Grove, Fla.	32.11	30.72	1.39	15.85	14.87
<i>Ceratonia siliqua</i> , Carob	Widely distributed in warm countries	fr.	Coconut Grove, Fla.	40.90	39.06	1.84	30.82	8.24
								21.10

*bu - bulk; fl. - flower; fr. - fruit; ib - inflorescence; le - leaves; rh - rhizomes; st - stems; ro - roots; tu - tubers; tw - twigs;

wp - whole plant; (1) young plant; (2) plant in fruit; (3) plant flower

ud fruiting.

TABLE II (Continued)

Botanical Name and Common Name if Known	Habitat	Part of Plant Analyzed*	Source of Material Analyzed	(Results Calculated to Moisture-Free Basis)			
				Total Extractive %	Soluble Extractives %	Tannin Insolubles %	Purity Basis Sol. Ext.
Leguminosae (Continued)							
<i>Cercis canadensis</i> , red bud, United States	le.	Raleigh, N. C.	43.30	39.74	3.56	26.36	13.38 33.67
<i>Haematoxylon campechianum</i> , Compechay wood, logwood	Mexico, Central America, West Indies	le, in.	Coconut Grove, Fla.	20.93	10.79	1.14	13.10 6.69 33.80
<i>Piptadenia macrocarpa</i> , Acacia grata	Brazil, Bolivia	le, fr.	Coconut Grove, Fla.	29.99	26.72	3.27	16.87 9.85 36.86
<i>Schotia transvaalensis</i>	Subtropic and S. Africa	le	Coconut Grove, Fla.	25.76	23.16	2.60	14.24 8.93 38.56
Liliaceae	Nolina species are desert plants	wp	Dur. Mex.	47.78	47.26	0.52	41.16 6.10 12.91
<i>Myricaceae</i>							
<i>Myrica carolinensis</i> , Bayberry	Nova Scotia to Fla. and Ga., Shores of Lake Erie	le, fr.	Raleigh, N. C.	14.95	13.76	1.19	6.83 6.93 50.36
Myrtaceae							
<i>Eucalyptus alba</i> , Poplar gum	Probably Australia	le, fr.	Coconut Grove, Fla.	24.87	23.07	1.80	12.50 10.57 45.82
<i>Feijoa sellowiana</i> , Pineapple guava	South America	le	Chico, California	24.48	22.30	2.18	14.09 8.21 36.82
<i>Feijoa sellowiana</i> , T.B. Pineapple guava	South America	le	Chico, California	29.45	28.07	1.38	16.97 11.10 39.54
<i>Psidium guajava</i> , Guava of the tropics	Native to tropical and subtropical America. Naturalized in parts of Asia and Africa	le, fr.	Coconut Grove, Fla.	26.98	23.52	3.46	14.43 9.09 38.65
<i>Psidium littorale</i>							
Onagraceae							
<i>Oenothera biennis</i> , European evening primrose	Introduced into Europe from Amer. Weed in Old World	wp, fr.	Beltsville, Maryland	28.44	26.34	2.10	15.26 11.08 42.07

*bu - bulk; fl. - flower; fr. - fruit; ib - inflorescent bud; in - leaves; rh - rhizomes; le - leaves; st - stems; ro - roots; tu - tubers; tw - twigs;
wp - whole plant; (1) young plant, (2) plant in fruit, (3) plant flowering and fruiting.

TABLE II (Continued)

Botanical Name and Common Name if Known	Habitat	Part of Plant Analyzed*	Source of Material Analyzed	(Results Calculated to Moisture-Free Basis)				Purity Basis
				Total Extractive %	Soluble Extractive %	Extractives in Non-Solubles %	Tannin %	
Orobanchaceae <i>Epifagus virginiana</i>		wp (3)	Beltsville, Maryland	47.47	39.66	7.81	24.01	15.65
Pittosporaceae <i>Pittosporum pentandrum</i>	le	Coconut Grove, Fla.	28.64	27.88	0.76	17.03	10.85	38.92
Rubiaceae <i>Adenostoma fasciculatum</i> , California	le	Murrieta, Calif.	39.09	37.17	1.92	23.03	14.15	38.07
	Heathlike evergreen shrub							
<i>Crataegus douglasii</i> ,	Br. Col. and N. Calif.	le, fr.	Chico, California	40.56	38.87	1.69	35.43	3.44
<i>Crataegus</i> , hawthorn	to Wyoming	le	Chico, California	30.23	28.47	1.76	22.60	5.88
<i>Crataegus duorivensis</i> ,								
<i>Crataegus</i> hawthorn								
<i>Crataegus lavallei</i>	Possibly same as <i>Carrierei</i> which orig. in France	le	Chico, California	35.35	31.91	3.44	25.67	6.24
<i>Eriobotrya japonica</i> , Loquat	China and Japan. Much planted in Gulf States	le, fr.	Coconut Grove, Fla.	29.06	28.59	0.47	22.43	6.16
<i>Malus kaido</i> , apple sp.	Northern Hemisphere	le	Chico, California	44.06	39.36	4.70	28.90	10.46
<i>Malus kaido</i> , apple sp.	Northern Hemisphere	le	Chico, California	44.56	42.99	1.57	31.05	11.94
Rubiaceae <i>Ixora coccinea</i>	East Indies	le, st, in.	Coconut Grove, Fla.	24.86	22.79	2.07	16.54	6.25
Sapindaceae <i>Dimocarpus longan</i>		fr.	Coconut Grove, Fla.	30.21	28.63	1.58	19.50	9.14
Sapotaceae <i>Achras sapota</i> , Sapodilla	American tropics	le, fr.	Coconut Grove, Fla.	35.75	32.51	3.24	24.88	7.63
<i>Lucuma salicifolia</i>	American tropics	le, fr.	Coconut Grove, Fla.	37.13	33.08	4.05	25.34	7.74
<i>Mimusops balata</i>	West Indies	le	Coconut Grove, Fla.	28.86	26.97	1.87	16.00	10.97
Scrophulariaceae <i>Chelone lyonii</i>	E. and Central U. S.	st, le, fr.	Highlands, N. C.	21.17	19.80	1.37	10.00	9.80
								49.49

*wp - bulk; fr. - flower; le - leaves; ib - inflorescence; rh - rhizomes; st - stems; ro - roots; tu - tubers; tw - twigs;
wp - whole plant; (1) young plant; (2) plant in fruit. (3) plant flowering and fruiting.

TABLE III
Data On Unanalyzed Samples Passing Preliminary Screening Tests

Botanical Name and Common Name if Known	Habitat	Part of Plant Tested*	Source of Material Tested
Aceraceae			
<i>Acer carpinifolium</i> , Hornbeam maple	Temperate zones	le	Coconut Grove, Florida
<i>Acer miyabei</i>	Japan	le	Glenn Dale, Maryland
Anacardiaceae			
<i>Pistacia lentiscus</i> , Mastic tree	Mediterranean region	fr	Chico, California
<i>Schinus terebinthifolius</i> , Pepper tree	Brazil	le, st	Coconut Grove, Florida
Aquifoliaceae			
<i>Ilex sp.</i> , Holly	Temperate & Tropic zones	le	Glenn Dale, Maryland
Betulaceae			
<i>Alnus japonica</i> , Alder	Japan	le	Glenn Dale, Maryland
<i>Carpinus cordata</i>	Japan, Korea	le	Glenn Dale, Maryland
<i>Carpinus tschonoskii</i>	China (?)	le	Glenn Dale, Maryland
Calycanthaceae			
<i>Calycanthus floridus</i> , Carolina Allspice	North America	le	Glenn Dale, Maryland
Caprifoliaceae			
<i>Abelia grandiflora</i> , <i>Abelia Diervilla "richesse"</i> , <i>Weigela Viburnum kansuense</i>	General cultivation	le, fl	Glenn Dale, Maryland
<i>Viburnum macrocephalum</i> , Chinese snowball	E. North America	le, fl	Glenn Dale, Maryland
	W. China	le, fl	Glenn Dale, Maryland
	China	fr	Glenn Dale, Maryland
Celastraceae			
<i>Euonymus phellomania</i> , Spindle tree	Central & East Asia	le	Glenn Dale, Maryland
<i>Tripterygium wilfordii</i>	Manchuria, Japan	le, fr	Glenn Dale, Maryland
Cunoniaceae			
<i>Weinmannia sp.</i>	South America	wp	Colombia, So. America
Cyrillaceae			
<i>Cyrilla racemiflora</i> , Leatherwood	North Carolina to Fla. to Texas	le	Glenn Dale, Maryland
Dilleniaceae			
<i>Actinidia chinensis</i>	East Asia	le	Glenn Dale, Maryland
Dioscoreaceae			
<i>Dioscorea composita</i>	Central America	tu	Mexico City
<i>Dioscorea polygonoides</i>	Central America	tu	Puerto Rico
<i>Dioscorea sativa</i>	Central America	le	El Salvador
<i>Dioscorea sp.</i>	Central America	rh, le, tu	South Africa
Ebenaceae			
<i>Diospyros kaki</i> , Persimmon	Mexico, West Indies	le	Chico, California
Elaeagnaceae			
<i>Hippophae rhamnoides</i>	Europe, W. & C. Asia	le	Glenn Dale, Maryland
Sea buckthorn			

*bu - bulk; fl. - flower; fr - fruit; ib - inflorescent bud; in - inflorescence; le - leaves; rh - rhizomes; st - stems; ro - roots; tu - tubers; tw - twigs; wp - whole plant; (1) young plant, (2) plant in fruit, (3) plant flowering and fruiting.

TABLE III (Continued)

Botanical Name and Common Name if Known	Habitat	Part of Plant Tested*	Source of Material Tested
Ericaceae			
<i>Enkianthus campanulatus</i>	Japan	le	Glenn Dale, Maryland
<i>Kalmia latifolia</i> American laurel	North America	le, fr	Glenn Dale, Maryland
<i>Leucothoe</i> sp.	N. & S. America, Asia	le	Glenn Dale, Maryland
Eucommiaceae			
<i>Eucommia ulmoides</i>	Central China	le	Glenn Dale, Maryland
Fagaceae			
<i>Quercus acutissima</i> Oak	Japan, Korea	le, tw, fr	Glenn Dale, Maryland
Hamamelidaceae			
<i>Fortunearia sinensis</i>	China	le	Glenn Dale, Maryland
<i>Hamamelis vernalis</i> Witch hazel	Mo. to La. to Okla.	le, fr	Glenn Dale, Maryland
<i>Loropetalum chinense</i>	C. & S. E. China	le	Glenn Dale, Maryland
<i>Parrotia persica</i>	Persia	le	Glenn Dale, Maryland
Hypericaceae			
<i>Hypericum patulum</i>	Japan	le, fl, fr	Beltsville, Maryland
Iridaceae			
<i>Watsonia wilmsii</i> , <i>Watsonia</i>	South Africa	bu	South Africa
Lauraceae			
<i>Sassafras albidum</i>	Massachusetts to N. C. to Ky.	le	Glenn Dale, Maryland
<i>Sassafras</i>			
Leguminosae			
<i>Acacia baileyana</i> , <i>Acacia</i>			
<i>Acacia melanoxylon</i> Blackwood acacia	Cult. in California	le	Chico, California
<i>Acacia pycnantha</i>		le	Chico, California
<i>Albizia lebbekoides</i> Lebbeck tree	Tropics	le, st	Coconut Grove, Florida
<i>Caesalpinia ferrea</i>	Tropics	le, fl	Coconut Grove, Florida
<i>Caesalpinia pulcherrima</i>	Tropics	le, fl, fr	Coconut Grove, Florida
<i>Cassia marginata</i>	Warmer parts of world	le, st	Coconut Grove, Florida
<i>Cassia nictitans</i>	Warmer parts of world	wp, fr	Raleigh, North Carolina
<i>Cassia renigera</i>	Warmer parts of world	le, fl	Coconut Grove, Florida
<i>Ceratonia siliqua</i> , Carob St. John's Bread	Mediterranean	fr, fl	Coconut Grove, Florida
<i>Ceris canadensis</i>		le	Raleigh, North Carolina
<i>Cercis siliquastrum</i> , Red Bud Judas tree	S. E. Europe	le	Chico, California
<i>Gymnocladus chinensis</i>	China	le	Glenn Dale, Maryland
<i>Haematoxylon campechianum</i> Haematoxylon		le, fl	Coconut Grove, Florida
<i>Indigofera chinensis incarnata</i> Indigo	China	le	Glenn Dale, Maryland
<i>Peltogyne nitens</i>		le, fr	Coconut Grove, Florida

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TABLE III (Continued)

Botanical Name and Common Name if Known	Habitat	Part of Plant Tested*	Source of Material Tested
Leguminosae (Continued)			
Wisteria floribunda	Japan	fr	Glenn Dale, Maryland
Wisteria			
Liliaceae			
Albuca sp.	South Africa	le	Cape Province, Africa
Nolina georgiana	Tropics	le, st	Raleigh, North Carolina
Nolina microcarpa		wp	Oracle, Arizona
Scilla sp., Squill	World-wide	bu	Transvaal
Smilax auriculata, Smilax	Eastern United States	rh	Southport, No. Carolina
Smilax mexicana	Mexico	rh	Jalcocotan, Mexico
Urginea burkei, Urginea		bu	Transvaal
Lythraceae			
Lagerstroemia indica	China	le, fl	Glenn Dale, Maryland
Crape Myrtle			
Lawsonia inermis,	North Africa	le, st, fr	Savannah, Georgia
Henna			
Magnoliaceae			
Liriodendron tulipifera	North America	le, st	Silver Spring, Maryland
Tulip tree			
Magnolia stellata	Japan	le	Glenn Dale, Maryland
Magnolia			
Moraceae			
Coussapoa sp.	Trop. S. America	le	Colombia
Coussapoa			
Myricaceae			
Myrica rubra	China, Japan	le	Savannah, Georgia
Wax myrtle			
Myrtaceae			
Callistemon linearis	Australia	fr	Chico, California
Bottle bush			
Eucalyptus nephophila	Australia	le	Glenn Dale, Maryland
Eucalyptus			
Eugenia coronata	South America	le, fl	Coconut Grove, Florida
Eugenia jambos	E. Indies	le, fr	Savannah, Georgia
Rose apple			
Myrciaria cauliflora	Brazil	le	Coconut Grove, Florida
Jaboticaba			
Nyssaceae			
Camptotheca acuminata		le	Chico, California
Oleaceae			
Fraxinus chinensis	Central & West China	fr	Glenn Dale, Maryland
Ash			
Olea europaea	Mediterranean	le	Murrieta, California
Olive			

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TABLE III (Continued)

Botanical Name and Common Name if Known	Habitat	Part of Plant Tested*	Source of Material Tested
Onagraceae <i>Circaeaa quadrifolia</i> v. canadensis Enchanters Nightshade	North America	wp	Burtonsville, Maryland
Oenothera biennis Evening primrose	North America	wp, fr	Beltsville, Maryland
Pinaceae <i>Larix</i> sp. Tamarack	N. Hemisphere High alt.	le	Glenn Dale, Maryland
Polygonaceae <i>Rumex crispus</i> Yellow dock	Europe	ro	Balmorhea, Texas
Eriogonum fasciculatum Eriogonum	W. N. America	le	Ensenada, Mexico
Polypodiaceae <i>Polystichum acrostichoides</i> Christmas or Dagger fern	Eastern United States	wp	Burtonsville, Maryland
Punicaceae <i>Punica granatum</i> Pomegranate	Persia	le, fr	Chico, California
Rhamnaceae <i>Ceanothus</i> sp. <i>Rhamnus davurica</i> Buckthorn	North America North China	le le	Glenn Dale, Maryland Glenn Dale, Maryland
Rosaceae <i>Agrimonia parviflora</i> agrimony	North Temperate Zone	wp	Burtonsville, Maryland
<i>Cerocarpus betuloides</i>		le	Chico, California
<i>Cotoneaster foveolata</i>	Central China	le	Glenn Dale, Maryland
<i>Crataegus azarolus</i>	North Africa, Asia	le, fr	Chico, California
<i>Crataegus</i> Hawthrone			
<i>Crataegus durobrivensis</i>	North Africa, Asia	fr	Chico, California
<i>Crataegus monogyna</i>	East & North Africa, Asia	le, fr	Chico, California
<i>Malus sieboldii</i> , apple	General	le	Glenn Dale, Maryland
<i>Malus</i> sp. apple	General	le, fr	Glenn Dale, Maryland
<i>Prunus serrulata</i> Flowering cherry	Japan, China	le	Glenn Dale, Maryland
<i>Prunus subhirtella</i> Japanese cherry	Japan	le	Glenn Dale, Maryland
<i>Pyracantha crenulata</i> Fire thorn	Himalayas	le	Glenn Dale, Maryland
<i>Pyrus ussuriensis</i>	Manchuria, N. China	le	Glenn Dale, Maryland
<i>Pyrus calleryana</i>	China	le	Glenn Dale, Maryland

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TABLE III (Continued)

Botanical Name and Common Name if Known	Habitat	Part of Plant Tested*	Source of Material Tested
Rosaceae (Continued)			
Rosa sp. Rose	General	fr	Glenn Dale, Maryland
Rutaceae			
Phellodendron sp. Cork tree	Japan, China	le	Glenn Dale, Maryland
Salicaceae			
Salix nigra Black willow	E. N. America	le, st	Silver Spring, Maryland
Sapindaceae			
Koelreuteria bipinnata	West China	fr	Coconut Grove, Florida
Saxifragaceae			
Deutzia sp.	East Asia	fr	Glenn Dale, Maryland
Hydrangea petiolaris Hydrangea	Japan	le	Glenn Dale, Maryland
Philadelphus henryi, Syringa Mock orange	Asia, N. America	le	Glenn Dale, Maryland
Scrophulariaceae			
Paulownia fortunei	S. E. China	le	Glenn Dale, Maryland
Tamaricaceae			
Tamarix juniperina Tomarick	Japan, N. China	le	Glenn Dale, Maryland
Theaceae			
Franklinia (Gordonia) alatamaha, Franklinia	Georgia	fl	Glenn Dale, Maryland
Ulmaceae			
Zelkova serrata	Japan	le	Beltsville, Maryland
Xyridaceae			
Xyris flexuosa	ro		Southport, N. Carolina

*bu - bulk; fl. - flower; fr - fruit; ib - inflorescent bud; in - inflorescence; le - leaves; rh - rhizomes; st - stems; ro - roots; tu - tubers; tw - twigs; wp - whole plant; (1) young plant, (2) plant in fruit, (3) plant flowering and fruiting.

REFERENCES

1. Western Hemlock Bark An Important Potential Tanning Material. C. C. Smoot and R. W. Frey. *U.S.D.A. Technical Bulletin*, No. 566 (1937). Hemlock Slabs as a Source of Pulp and Tannin. N. F. Roger, W. H. Koepp, and E. L. Griffin, Jr. *J. Amer. Leather Chemists Assoc.*, **49**, 75 (1954).
2. Tannin Content of Sitka Spruce Bark. R. W. Frey and I. D. Clarke. *Ibid.*, **36**, 576 (1941).
3. Study of the Tannin Contents of Barks from the Florida Scrub Oaks, *Quercus laevis* and *Q. cinerea*. J. S. Rogers, H. N. Calderwood, and C. W. Beebe. *Ibid.*, **45**, 733 (1950).
4. Tennessee Valley Oak Bark as a Source of Tannin. C. W. Beebe, F. P. Luvisi, and M. L. Happich, *Ibid.*, **48**, 32 (1953).
5. Tannin Content and Other Characteristics of Native Sumac in Relation to Its Value as a Commercial Source of Tannin. I. D. Clarke, J. S. Rogers, A. F. Sievers, and H. Hopp, *U.S.D.A. Technical Bulletin* 986 (1949).

6. Canaigre Investigations I. A Review and Preliminary Report. J. S. Rogers and G. A. Russell. *J. Amer. Leather Chemists Assoc.*, **39**, 467 (1944).
II. Dehydration of Bulk Lots of Canaigre Roots in the Locality Where Harvested. G. A. Russell, J. S. Rogers, and E. C. Stevenson. *Ibid.*, **39**, 479 (1944).
III. An Improved Method of Extraction. T. C. Cordon, C. W. Beebe, and J. S. Rogers. *Ibid.*, **42**, 118 (1947).
IV. Fermentation of Liquors for Production of High Purity Extracts. T. C. Cordon, C. W. Beebe, and J. S. Rogers. *Ibid.*, **42**, 128 (1947).
V. Analytical Studies on the Extraction of Canaigre Roots with Water and with Acetone-Water Mixtures. F. P. Luvisi and J. S. Rogers. *Ibid.*, **43**, 166 (1948).
VI. Extraction with Organic Solvent-Water Solutions. F. P. Luvisi., T. C. Cordon, C. W. Beebe, and J. S. Rogers. *Ibid.*, **44**, 707 (1949).
VII. Fermentation of Extract Liquors and Identity of the Bacteria and Products of Their Growth. T. C. Cordon. *Ibid.*, **45**, 485 (1950).
VIII. Preparation of Tanning Extracts by Continuous Countercurrent Extraction. R. M. Rieder, N. F. Roger, G. W. M. Phillips, and R. K. Eskew. *Ibid.*, **46**, 188 (1951).
IX. Laboratory Tannage of Heavy Leather. C. W. Beebe, W. S. Kip, II, and J. S. Rogers. *Ibid.*, **46**, 197 (1951).
X. Fermentation of Canaigre Liquors by Yeasts. T. C. Cordon and A. L. Everett. *Ibid.*, **49**, 43 (1954).
Countercurrent Stationary Vat Leaching of Shredded Canaigre Roots. R. M. Rieder, V. A. Turkot, R. K. Eskew, and G. W. M. Phillips. *Ibid.*, **46**, 264 (1951).
7. Steroidal Sapogenins, VII Survey of Plants for Steroidal Sapogenins and Other Constituents. M. E. Wall, M. M. Krider, C. F. Krewson, C. R. Eddy, J. J. Willaman, D. S. Correll, and H. S. Gentry. *J. Amer. Pharmaceutical Assoc., Scientific Edition*, **43**, 1 (1954).
8. Steroidal Sapogenins, XIII Supplementary Table of Data for Steroidal Sapogenins VII. M. E. Wall, M. M. Krider, C. F. Krewson, C. R. Eddy, J. J. Willaman, D. S. Correll and H. S. Gentry. *U.S.D.A. AIC-363.* (1954).
9. Methods of Sampling and Analysis. *The American Leather Chemists Association* (1946).
10. The Standard Cyclopedie of Horticulture. L. H. Bailey. 3 vols. The MacMillan Co., New York (1941).
Hortus. L. H. Bailey and E. Z. Bailey. The MacMillan Co., New York (1930).